OPC-UA as enabling technology for plug-and-work on MES level

Miriam Schleipen
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Agenda

1. Terms and motivation
2. Goal and enabler: OPC UA
3. Plug-and-work on MES level by means of OPC UA based middleware
4. Conclusion and Outlook
1. Definition 'production-related IT-Systems' [Betriebshütte, VDI 5600-1]
1. MES at Fraunhofer IOSB

- Manufacturing Execution Systems (MES)
  - Are production management software systems with direct access to the field controllers e.g. PLCs
  - Aggregate actual state of production and calculate KPIs
  - Are a system type with specific domain language within the heterogeneous IT landscape in production environment
  - Collect and use data and information from different heterogeneous data sources
- The integrated monitoring & reporting system from IOSB consists of
  - ProVis.Agent® for monitoring & control,
  - ProVis.Visu® for real-time visualization,
  - ProVis.Paula® for web based reporting.

1. Motivation

- Plant planning process = complex process divided into several planning phases with many different disciplines involved
- Before using a production monitoring & control system: Engineering
- Engineer gets information as hall layout, signal list, etc. and creates visualization manually → time-intensive, cost-intensive, error-prone
- Usage of one homogeneous data and modeling format for the exchange between different tools would help
New components identified!
2. Goal and enabler

- Consistent data for MES and engineers involved in production planning
- Enhanced data exchange
- Integrated computer-assisted planning
- Simplified production planning and re-planning (on MES level)

Problems
- What to communicate? (content)
- How to communicate? (process)

Enabling Technology: OPC-UA

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2. OPC Unified Architecture (OPC UA)

- Provides mechanisms for the standardized, asynchronous, distributed communication
- Supports process communication in a structured way
- Unifies all previous OPC-based technologies under a ‘platform-independent umbrella’
- Base services: abstract method descriptions
- User-defined information model: Full-mesh network of nodes
- Fraunhofer IOSB is corporate member in OPC Foundation
- Since 2007 we use OPC UA in different industrial research & development projects
- Production monitoring & control system ProVis.Agent supports OPC UA as one communication possibility

Source: OPC DevCon 10.-12.10. 2006, München
T.J. Burke, OPC Foundation
2. OPC UA as enabling technology

- Within planning phases: Different professional and specialized tools supporting the engineer
- At transition from one phase to another:
  - Data incompatibility problems
  - Semantic gap
  - Data exchange via excel, telephone, or paper based information (e.g. printed hall layout)
- **Solution:**
  - Intelligent middleware using OPC-UA

3. Intelligent middleware using OPC-UA

- **How to communicate?**
  - OPC UA as standardized communication technology for planning data & electronic change propagation
- **What to communicate?**
  - AutomationML as standardized exchange format & integrated data model
- **Supports mechatronic, cross-discipline plant engineering**
3. Data management and communication middleware

- **Architecture:**
  - Middleware server
  - Clients with adapters to middleware
- **Requirements**
  - Read and write data in different structures
  - Support implementation of AutomationML as data model
  - Connection monitoring and communication
    - Problem handling (connection interrupt, communication problems, …)
    - Access rights
    - Real-time requirements ↔ no data loss
    - Asynchronous data transmission
    - Support of different HW platforms (e.g. Windows, Android, …)
3. Data management and communication middleware

- Standardized communication
- Well-defined interfaces for all involved partners
- Integrated information model
- Change management
- Change propagation
- Different views on data

→ OPC UA was made for these requirements (originally)
→ No further effort

3. AutomationML as glue

- Unified language
- Plant description
- Close gaps
  - Between product development and production
  - For interoperability between tools
  - For all phases of engineering
  - Based on a scalable data format
  - As open standard with market acceptance
- Actual status: Progress towards IEC standard series

Get rid of the paper interface!
www.automationML.org
3. Mechatronical units with AutomationML

- Topology
- Geometry
- Kinematics
- Motion planning
- Behavior
- Handling processes

3. Top-level architecture of AutomationML

AutomationML

CAEX IEC 62424
Top level format
- Plant topology
- Information
- Plants
- Cells
- Components
- Attributes
- Interfaces
- Relations
- References

Object A
Object A

CAEX IEC 62424

Object A

COLLADA
- Geometry
- Kinematics

PLCopen XML
- Behaviour
- Sequencing

Further XML Standard format
- Further aspects of engineering information
3. Example: AutomationML model – plant components

- AutomationML includes different library types (plant component types, interfaces and roles) and a concrete plant hierarchy with its components

- Plant component TB1 with Name, ID

- Derived from plant type Transportband

3. Example: AutomationML model – information about single component

- Detail information for TB1 (CAEX and COLLADA)

- Frame: Position and orientation in 3D space

- Different interfaces

- 3D-representation (Collada)

- Semantic/meaning of component: Transport
3. Data base, data modeling and data management

- Communication infrastructure based on OPC Unified Architecture (UA)
- Implementation of AutomationML model in information model of UA server

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CAEXObject
  - ID
  - Name
  - Description
  - Revision
  - Additional Information

EventTypes
  - Event
  - Type

Modified:
  - MethodsAndData
  - Operations
  - Organizers
  - Groups
  - Objects

WriteValue
  - Edit

WriteValues
  - Value

ResetAutomatic
  - Value

AddToAddressSpace
  - Value

DeleteAutomationMLObj
  - Value
```

3. Example: Digital Engineering Table - DigET

- Public funded research project, 2010-2012
- Interactive assistant system for multi user engineering
- Combination of standards such as AutomationML and OPC UA with assistance mechanism and an interactive environment
- Consistent planning and intuitive interaction with IT systems (e.g. via gestures)
- Multi display hardware environment with interaction possibility and collaboration assistance
- OPC UA middleware with integrated AutomationML information model and conflict handling
4. Conclusion and Outlook

- Conclusion
  - MES needs engineering information from different other tools and disciplines
  - Need for an integrated data model
  - OPC UA is enabler for plug-and-work mechanism
  - Combination of standardized data format AutomationML and standardized communication and data processing technology OPC UA
  - Integration of AutomationML as information model in OPC UA

- Outlook
  - Necessity to rely on existing UA companion standards
  - (MES is current topic within OPC Foundation)

Thank you for the attention!
Impressum

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Miriam Schleipen
Fraunhofer IOSB

miriam.schleipen@iosb.fraunhofer.de
www.irosb.fraunhofer.de/ilt
www.kikblog.de
Tel.: +49-721-6091-382
Fax: +49-721-6091-413